

ADJUSTING A SIGNAL AT A DIVERSITY SYSTEM

TECHNICAL FIELD

This invention relates generally to the field of communication systems and more specifically to adjusting a signal at a diversity system.

BACKGROUND

A diversity antenna system of a mobile device may include antenna elements that receive signals from and transmit signals to a base station. Signal reception and transmission may be improved by steering the radiation pattern of the antenna elements. For diversity reception, the signal-to-noise ratio (SNR) of an incoming signal may be improved by directing the main lobe of the pattern towards the signal. For diversity transmission, the pattern may be directed toward the base station to improve transmission. An adjuster may be used to adjust a signal to steer the radiation pattern. Known techniques for adjusting signals, however, may be inefficient. Efficient adjustment of signals may be desired.

SUMMARY

In accordance with an embodiment of the present invention, disadvantages and problems associated with previous techniques for communication systems may be reduced or eliminated.

5           According to one embodiment of the present invention, adjusting a signal includes receiving signals and quality indicators at an adjuster. The quality indicators include as least one of a power control group boundary signal, a power control group index, a PN code per active finger, a reverse power control bit per active finger, an energy per chip over noise power spectral density ratio per active finger for a pilot  
10   channel, channel estimates I/Q per active finger, an energy per bit over power spectral density for a traffic channel, a total receive power, a transmit AGC signal, and any combination of the preceding. A signal adjustment is calculated according to the quality indicators, and the signals are adjusted according to the signal adjustment to yield adjusted signals.

15           Certain embodiments of the invention may provide one or more technical advantages. A technical advantage of one embodiment may be that an adjuster may adjust the phase, the amplitude, or both phase and amplitude of signals in accordance with one or more quality indicators in order to create differences between signals. The differences may be used to differentiate the signals.

20           Certain embodiments of the invention may include none, some, or all of the above technical advantages. One or more other technical advantages may be readily apparent to one skilled in the art from the figures, descriptions, and claims included herein.

BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the present invention and its features and advantages, reference is now made to the following description, taken in conjunction with the accompanying drawings, in which:

5           FIGURE 1 is a block diagram illustrating an embodiment of a network that communicates with a mobile device that has a diversity system for adjusting a phase of a signal;

FIGURE 2 is a block diagram illustrating an embodiment of a diversity system of the mobile device of FIGURE 1;

10           FIGURE 3 is a block diagram illustrating one embodiment of a diversity system that includes one embodiment of a transmit adjuster for adjusting signals;

FIGURE 4 is a block diagram illustrating one embodiment of a diversity system that includes embodiments of a receive adjuster and a transmit adjuster for adjusting signals; and

15           FIGURE 5 is a block diagram illustrating another embodiment of a diversity system that includes one embodiment of a transmit adjuster for adjusting signals.

DETAILED DESCRIPTION OF THE DRAWINGS

Embodiments of the present invention and its advantages are best understood by referring to FIGURES 1 through 5 of the drawings, like numerals being used for like and corresponding parts of the various drawings.

5       FIGURE 1 is a block diagram illustrating an embodiment of a network 10 that communicates with a mobile device that has a diversity system for adjusting a signal. In general, the mobile device includes antenna elements that receive and transmit signals, where each signal has an initial phase and an initial amplitude. The diversity system may adjust the phase, the amplitude, or both the phase and amplitude of the  
10       signals in accordance with one or more quality indicators in order to create differences between signals. The differences may be used to differentiate the signals.

According to the illustrated example, a mobile device 20 communicates with a network 10 that includes a base station 30, a switch 32, and a communication network 34 coupled as shown in FIGURE 1. Mobile device 20 includes an antenna system 40  
15       that receives signals transmitted by base station 30 and transmits signals to base station 30. A signal comprises an electrical quantity such as current or voltage that may be used to communicate information between, for example, base station 30 and mobile device 20. For example, signals may comprise data packets communicating information such as data, video, multimedia, any other suitable type of information, or  
20       any combination of the preceding. A signal may comprise a radio frequency signal.

Mobile device 20 has a diversity system that includes one or more adjusters. An adjuster adjusts a signal in accordance with quality indicators. Mobile device 20 may comprise, for example, a personal digital assistant, a cellular telephone, a mobile handset, or any other device suitable for communicating signals to and from network  
25       10. Mobile device 20 may support, for example, simple Internet Protocol (IP), mobile IP, or any other suitable communication protocol, and may support cellular Code Division Multiple Access (CDMA), Personal Communications Service (PCS) CDMA, Advanced Mobile Phone Service (AMPS), or other communication technology.

Network 10 may comprise one or more devices operable to communicate with  
30       mobile device 20. According to the illustrated embodiment, network 10 includes base station 30, switch 32, and communication network 34. Network 10, however, may include more, fewer, or other suitable devices. Network 10 may support, for example,

cellular technology, non-cellular technology such as WiMAX, wireless technology, point-to-point technology, other suitable technology, or any combination of the preceding.

Base station 30 provides mobile device 20 with access to network 10. Base station 30 includes a base transceiver station and a base station controller. The base transceiver station communicates signals to and from mobile device 20. The base station controller manages the operation of the base transceiver station. The wireless link between mobile device 20 and base station 30 is typically a radio frequency link that may be cellular in network organization. Base station 30 transmits signals associated with the base station coverage area as dictated by switch 32 and communication network 34.

Communication network 34 allows mobile device 20 to communicate with other networks or devices. Communication network 34 may comprise all or a portion of a public switched telephone network (PSTN), a public or private data network, the Internet, a wireline or wireless network, a local, regional, or global communication network, an enterprise intranet, other suitable communication link, or any combination of the preceding.

Various modifications, additions, or omissions may be made to network 10 without departing from the scope of the invention. Moreover, the operations of network 10 may be performed using logic comprising hardware, software, or any combination of the preceding.

FIGURE 2 is a block diagram illustrating one embodiment of a diversity system 22 of mobile device 20 of FIGURE 1. According to the illustrated embodiment, diversity system 22 includes antenna system 40, radio frequency (RF) filters 72, one or more adjusters 74, one or more converters 76, and a baseband processor 78 coupled as shown. A channel 68 of diversity system 22 refers to any portion of system 100 that includes a path for a signal. As an example, channel 68a includes adjuster 74a and converter 76a, and channel 68b includes adjuster 74b and converter 76b.

According to one embodiment of operation, antenna system 40 receives receive signals 60 that carry encoded information, and RF filters 72 filter receive signals 60. Adjuster 74a adjusts a receive signal 60 according to quality indicators to

yield an adjusted receive signal 60. Adjuster 74a combines adjusted and unadjusted signals 60 to form a combined signal. The adjustment may improve the quality of the signal. Converter 76a converts the frequency of combined receive signal 62 from an RF frequency band to baseband frequency band. Baseband processor 78 processes  
5 combined receive signal 62 to yield decoded information.

According to one embodiment of operation, baseband processor 78 encodes information of a transmit signal 60 to be transmitted. Converter 76b converts the frequency of transmit signal 60 from a baseband frequency band to an RF frequency band. Adjuster 74b splits transmit signal 60 into split signals and adjusts one or more  
10 of the split signals according to quality indicators to yield one or more adjusted transmit signals 60. The adjustment may improve the quality of transmitted signals as received by a receiver. RF filters 72 filter transmit signals 60, and antenna system 40 transmits transmit signals 60.

According to one embodiment, antenna system 40 may comprise any suitable  
15 number of antenna elements 70. In the illustrated embodiment, antenna system 40 comprises antenna elements 70a and 70b, each of which may transmit and receive signals. Antenna elements 70 may comprise any suitable antenna, for example, wire antennas, stubby antennas, patch antennas, or magnetic antennas. Antenna elements 70 are separated by a distance  $d$ . Distance  $d$  may be defined as any separation such  
20 that signals transmitted from or received by the antenna elements 70 have a low correlation coefficient. According to one embodiment, distance  $d$  may be in a range between 0.10 to 1.0 wavelength  $\lambda$ , for example, approximately  $0.13\lambda$ , to yield a correlation coefficient of approximately 0.7.

Radio frequency filters 72 filter signals 60. In the illustrated embodiment,  
25 signal 60 received or transmitted by antenna element 70a is filtered by RF filter 72a, and signal 60 received or transmitted by antenna element 70b is filtered by RF filter 72b. According to one embodiment, RF filters 72 comprise duplexors, diplexors, or both. In general, a duplexor comprises a filter that filters signals according to the frequency separation of the transmit and receive frequencies, which allows a  
30 transmitter and receiver to use the same antenna element 70. A diplexor may comprise a switch, a filter, or any suitable device for separating signal frequencies according to different frequency bands. For example, frequency bands that may be diplexed are the

800 MHz band and the 1.9 GHz band. Such diplexor operation may be useful for mobile devices 20 capable of operating in dual band systems.

According to one embodiment, signal 60 received by antenna element 70a may be filtered by a duplexor configured to filter receive frequencies. A duplexor separates the signal to obtain a particular frequency band at which mobile device 20 operates. A signal received at antenna element 70b may be filtered in a similar manner. Other filters may be used as RF filters 72 without deviating from the scope of the invention. Any suitable number of antenna elements 70 may be used in combination with any suitable number of RF filters 72 to produce any suitable number of desired filtered signals.

Adjuster 74 adjusts a signal 60 in accordance with one or more quality indicators to yield an adjusted signal 60. Adjuster 74 may adjust a signal 60 by shifting the phase of signal 60, changing the amplitude of signal 60, performing any other suitable adjustment, or any combination of the preceding. The quality indicators may be calculated by adjuster 74, received from baseband processor 78, received from an alternative source to baseband processor 78, or any combination of the preceding. Adjuster 74 may calculate at least some of the quality indicators, receive at least some of the quality indicators from baseband processor 78, receive at least some of the quality indicators from an alternative source to baseband processor 78, or any combination of the preceding.

According to one embodiment of an operation to receive signals 60, adjuster 74a comprises a receive adjuster 74a. Receive adjuster 74a adjusts filtered receive signals 60 and combines the adjusted filtered receive signals 60 to yield a reduced number of combined receive signals 60. According to one embodiment of an operation to transmit signals 60, adjuster 74b comprises a transmit adjuster 74b. Transmit adjuster 74b splits combined transmit signal 60 to yield an increased number of separate transmit signals 60, and adjusts the separate transmit signals 60. Diversity system 22 may include a receive adjuster 74a, a transmit adjuster 74b, or both.

Adjuster 74 may be operable to function in analog mode or digital mode, in baseband mode or RF mode, and therefore may be located at any suitable location of mobile device 20. For example, adjuster 74 may adjust baseband signals in either digital or analog mode. As another example, adjuster 74 may adjust RF signals.



According to one embodiment, adjuster 74 may be implemented using multiplier techniques, summation techniques, or both. Multiplier techniques may use devices, logic, circuits, hardware, software, processors, filters, any other device suitable for multiplying signals, or any combination of the preceding. Summation techniques may use devices, logic, circuits, hardware, software, processors, filters, combiners, any other device for summing signals, or any combination of the preceding. Adjuster 74 may support any suitable band such as cellular CDMA, PCS CDMA, other band, or any combination of the preceding.

Converter 76a may comprise an RF-to-receive baseband converter that downconverts the frequency of combined receive signal 60 from an RF frequency band to a baseband frequency band. Converter 76b may comprise a receive baseband-to-RF converter that upconverts the frequency of combined transmit signal 60 from a baseband frequency band to an RF frequency band. It is understood that an RF frequency band may include any frequency band in the range of mobile and fixed wireless communication, such as the 800 MHz band, 1.9 GHz band, or any other suitable frequency band suitable for operating as a carrier of network 10.

According to one embodiment, baseband processor 78 may provide adjusters 76 with quality indicators using a bus 80. Baseband processor 78 also processes a receive signal 60 to yield decoded information. To yield decoded information, baseband processor 78 spreads receive signal 60 into symbol level signals, and then combines the symbol level signals to retrieve the information. The symbol level signals may be combined coherently based on maximal ratio combining.

Various modifications, additions, or omissions may be made to system 22 without departing from the scope of the invention. For example, baseband processor 78 may include additional logic to process signals according to a wireless protocol used by network 10. As another example, adjuster 74 may be modified to include an antenna combiner or any element suitable for summing analog signals. As yet another example, adjuster 74 may be located anywhere in mobile device 20 to adjust and combine RF signals, baseband signals, filtered signals, or any suitable signal. For example, adjuster 74 may be located between antenna system 40 and RF filters 72. As yet another example, system 22 may include any number of receive adjusters 74a, transmit adjusters 74b, or both, for example, system 22 may include any number of

receive adjusters 74a and no transmit adjusters 74b, or system 22 may include any number of transmit adjusters 74b and no receive adjusters 74a. Moreover, the operations of system 22 may be performed using logic comprising hardware, software, or any combination or arrangement of processors or modules suitable for  
5 adjusting a signal as disclosed.

FIGURE 3 is a block diagram illustrating one embodiment of diversity system 22a that includes one embodiment of transmit adjuster 74b that adjusts signals in accordance with quality indicators received from baseband processor 78. According to the illustrated embodiment, diversity system 22a includes antenna system 40, radio  
10 frequency (RF) filters 72, transmit adjuster 74b, one or more low noise amplifiers (LNAs) 90, one or more surface acoustic wave filters (SAWs) 92, converters 76, and baseband processor 78 coupled as shown. According to the embodiment, diversity system 22a includes channel paths that support different bands. As an example, one channel path may support PCS CDMA, and another channel path may support cellular  
15 CDMA.

According to the illustrated embodiment, diversity system 22a includes features for receiving signals such as antenna elements 70. Antenna elements 70 receive signals that carry encoded information. RF filters 72 filter the received signals, where each RF filter 72 includes a diplexor 110 and one or more duplexors  
20 112. Diplexor 110 separates signal frequencies according to different frequency bands, for example, PCS CDMA and cellular CDMA bands. LNAs 90 amplify the signals, and SAWs 92 filter the signals.

Converters 76a comprise down-converters that convert the frequency of received signals from an RF frequency band to baseband frequency band. According to the illustrated embodiment, a converter 76a includes a local oscillator (LO) 114,  
25 mixers 116, a low pass filter (LPF) 120, and an interface 122 coupled as shown. Local oscillator 114 receives signals from a receive voltage-controlled oscillator (VCO) 126 and a receive phase-locked loop (PLL) 128 and generates a clock signal. Mixers 116 mix signals from SAWs 92 and the clock signal from local oscillator 114. LPF 120  
30 filters signals from mixers 116. Interface 122 communicates with baseband processor 78.

Baseband processor 78 processes received signals to yield decoded information, and encodes information of outgoing signals to be transmitted. According to the illustrated embodiment, baseband processor 78 includes a receive input 130, a transmit output 132, and a control interface 134. Receive input 130  
5 receives signals from converters 76a, and transmit output 132 sends outgoing signals to converter 76b. Control interface 134 communicates with converters 76 and transmit adjuster 74b.

According to the illustrated embodiment, diversity system 22a includes features for transmitting signals such as converter 76b. Converter 76b comprises an  
10 up-converter that converts the frequency of outgoing signals from a baseband frequency band to an RF frequency band. According to the illustrated embodiment, converter 76b includes a local oscillator (LO) 140, a quad modulator 142, an automatic gain control (AGC) 144, amplifiers 146, and an interface 148 coupled as shown. Local oscillator 140 receives signals from a transmit voltage-controlled  
15 oscillator (VCO) and a transmit phase-locked loop (PLL) 149. Quad modulator 142 modulates signals, AGC 144 controls the amplitude of signals, and amplifiers 146 amplify signals. Interface 148 communicates with baseband processor 78, converter 76a, and transmit adjuster 74b.

According to one embodiment, transmit adjuster 74b adjusts signals in  
20 accordance with quality indicators received from baseband processor 78. Transmit adjuster 74b may include an interface, control logic, a digital processing block, a test bus, a memory bus, one or more vector modulators, one or more driver amplifiers, one or more power amplifiers, other suitable device, or any combination of the preceding. The control logic controls the operation of the vector modulators and the driver  
25 amplifiers. The control logic receives quality indicators from baseband processor 78, determines signal adjustments based on the quality indicators, and instructs the vector modulators, driver amplifiers, or both to implement the signal adjustments.

A quality indicator may comprise a value for a parameter that may be used to measure signal quality. For illustration purposes only, if CDMA technology is used,  
30 quality indicators may describe CDMA power control groups. Quality indicators for each CDMA power control group may be used. Quality indicators may include, for example, a power control group boundary signal, a power control group index, a PN

code per active finger, a reverse power control bit per active finger, an energy per chip over noise power spectral density ( $E_{pc}/N_t$ ) ratio per active finger, channel estimates I/Q per active finger, an energy per bit over noise power spectral density ( $E_b/N_t$ ), a transmit AGC signal, and a total receive power.

5           A power control group boundary signal indicates the start of a power control group. According to one embodiment, a strobe signal may be synchronized with a power control group boundary signal at, for example, approximately 800 MHz. A power control group index comprises a sequence identifier such as a sequence number. A PN code per active finger identifies a base station or sector. A reverse  
10 power control bit per active finger, which may be transmitted by a base station, indicates whether the mobile device needs to increase or decrease transmission power. The energy per chip ( $E_{pc}$ ) indicates the energy per chip of the pilot channel, and the noise power spectral density ( $N_t$ ) is the noise power spectral density within the bandwidth, so energy per chip over noise power spectral density ratio per active finger  
15 may indicate signal quality. Channel estimates I/Q per active finger may be used to demodulate signals at a channel, and may be extracted from the forward pilot channel. Energy per bit ( $E_b$ ) over noise power spectral density ( $N_t$ ) indicates the quality of traffic channels, and may be provided for the fundamental channel, supplemental channel, or both. The total receive power may describe the total receive power per  
20 symbol.

Transmit adjuster 74b may use any quality indicator or any combination of quality indicators to determine the signal adjustments. According to one embodiment, transmit adjuster 74b may use the following quality indicators, which may be given for each power control group: a power control group boundary signal, a PN code per  
25 active finger, a reverse power control bit per active finger, an energy per chip over noise power spectral density ratio per active finger, channel estimates I/Q per active finger, a transmit AGC signal, a total receive power, or any combination of the preceding.

According to the illustrated embodiment, transmit adjuster 74b includes  
30 amplifiers 160 and 164 and SAWs 162 and 166. Amplifiers 160 and 164 amplify outgoing signals, and SAWs 162 and 164 filter the outgoing signals. According to one embodiment, amplifiers 160a and 164a amplify outgoing signals for one channel path,

and amplifiers 160b and 164b amplify outgoing signals for another channel path. SAWs 162a and 164a filter the outgoing signals channel path for one channel path, and SAWs 162b and 164b filter the outgoing signals for another channel path. Transmit adjuster 74b may be fabricated using, for example, a silicon germanium (SiGe) bipolar complementary metal oxide semiconductor (BiCMOS) process, and  
5 may be fabricated as a Very Thin Profile Quad Flat Non Leaded (VQFN) package.

RF filters 72b filter outgoing signals, and may include a diplexor 110 and one or more duplexors 112. Antenna elements 70 of antenna system 40 transmits the signals.

10 Various modifications, additions, or omissions may be made to system 22a without departing from the scope of the invention. Moreover, the operations of system 22a may be performed using logic comprising hardware, software, or any combination or arrangement of processors or modules suitable for adjusting a signal as disclosed.

15 FIGURE 4 is a block diagram illustrating another embodiment of diversity system 22b that includes embodiments of receive adjuster 74a and transmit adjuster 74b that adjust signals in accordance with quality indicators received from baseband processor 78. According to the illustrated embodiment, diversity system 22b includes antenna system 40, radio frequency (RF) filters 72, receive adjuster 74a, transmit  
20 adjuster 74b, converters 76, one or more surface acoustic wave filters (SAWs) 92, and baseband processor 78 coupled as shown. According to the embodiment, diversity system 22b includes channel paths that support different bands. As an example, one channel path may support PCS CDMA, and another channel path may support cellular CDMA.

25 According to the illustrated embodiment, diversity system 22b includes features for receiving signals such as antenna elements 70. Antenna elements 70 receive signals that carry encoded information. RF filters 72 filter the received signals, where each RF filter 72 includes a diplexor 110 and one or more duplexors 112. Diplexor 110 separates signal frequencies according to different frequency  
30 bands, for example, PCS CDMA and cellular CDMA bands.

According to the embodiment, receive adjuster 74a adjusts signals in accordance with quality indicators received from baseband processor 78. Receive

adjuster 74a may include an interface, control logic, one or more vector modulators, and one or more low noise amplifiers. The control logic controls the operation of the vector modulators and low noise amplifiers. The control logic receives quality indicators, determines signal adjustments based on the quality indicators, and instructs  
5 the vector modulators to implement the signal adjustments. According to one embodiment, receive adjuster 74a may use the following quality indicators, which may be given for each power control group: a power control group boundary signal, a power control group index, a PN code per active finger, an energy per chip over noise power spectral density ( $E_{pc}/N_t$ ) ratio per active finger, channel estimates I/Q per  
10 active finger, an energy per bit over noise power spectral density ( $E_b/N_t$ ), a transmit AGC signal, a total receive power, or any combination of the preceding. Receive adjuster 74a may be fabricated using, for example, SiGe BiCMOS process, and may be fabricated as a VQFN package.

SAWs 92 filter the received signals. Converter 76a comprises a down-  
15 converter that converts the frequency of received signals from an RF frequency band to baseband frequency band. According to the illustrated embodiment, converter 76a includes a local oscillator (LO) 114, mixers 116, a low pass filter (LPF) 120, and an interface 122 coupled as shown. Local oscillator 114 receives signals from a receive voltage-controlled oscillator (VCO) 126 and a receive phase-locked loop (PLL) 128  
20 and generates a clock signal. Mixers 116 mix signals from SAWs 92 and the clock signal from local oscillator 114. LPF 120 filters signals from mixers 116. Interface 122 communicates with baseband processor 78.

Baseband processor 78 processes received signals to yield decoded information, and encodes information of outgoing signals to be transmitted.  
25 According to the illustrated embodiment, baseband processor 78 includes a receive input 130, a transmit output 132, and a control interface 134. Receive input 130 receives signals from converters 76a, and transmit output 132 sends outgoing signals to converter 76b. Control interface 134 communicates with converters 76 and transmit adjuster 74b.

30 According to the embodiment, transmit adjuster 74b adjust signals in accordance with quality indicators received from baseband processor 78. Transmit adjuster 74b is described in more detail with reference to FIGURE 3. RF filters 72b

filter outgoing signals, and may include a diplexor 110 and one or more duplexors 112. Antenna elements 70 of antenna system 40 transmits the signals.

Various modifications, additions, or omissions may be made to system 22b without departing from the scope of the invention. Moreover, the operations of system 22b may be performed using logic comprising hardware, software, or any combination or arrangement of processors or modules suitable for adjusting a signal as disclosed.

FIGURE 5 is a block diagram illustrating another embodiment of a diversity system 22c that includes one embodiment of a transmit adjuster 74b that may adjust signals using one or more quality indicators that need not be provided by baseband processor 78. As an example, transmit adjuster 74b may be used with a closed interface baseband processor 78. According to the illustrated embodiment, diversity system 22c includes antenna system 40, radio frequency (RF) filters 72, transmit adjuster 74b, one or more low noise amplifiers (LNAs) 90, one or more surface acoustic wave filters (SAWs) 92, converters 76, and baseband processor 78 coupled as shown. According to the embodiment, diversity system 22c includes channel paths that support different bands. As an example, one channel path may support PCS CDMA, and another channel path may support cellular CDMA.

According to the illustrated embodiment, diversity system 22c includes features for receiving signals such as antenna elements 70. Antenna elements 70 receive signals that carry encoded information. RF filters 72 filter the received signals, where each RF filter 72 includes a diplexor 110 and one or more duplexors 112. Diplexor 110 separates signal frequencies according to different frequency bands, for example, PCS CDMA and cellular CDMA bands. LNAs 90 amplify the signals, and SAWs 92 filter the signals.

Converters 76a comprise down-converters that convert the frequency of received signals from an RF frequency band to baseband frequency band. According to the illustrated embodiment, a converter 76a includes a local oscillator (LO) 114, mixers 116, a low pass filter (LPF) 120, and an interface 122 coupled as shown. Local oscillator 114 receives signals from a receive voltage-controlled oscillator (VCO) 126 and a receive phase-locked loop (PLL) 128 and generates a clock signal. Mixers 116 mix signals from SAWs 92 and the clock signal from local oscillator 114. LPF 120

filters signals from mixers 116. Interface 122 communicates with baseband processor 78.

Baseband processor 78 processes received signals to yield decoded information, and encodes information of outgoing signals to be transmitted.  
5 According to the illustrated embodiment, baseband processor 78 includes a receive input 130, a transmit output 132, and a control interface 134. Receive input 130 receives signals from converters 76a, and transmit output 132 sends outgoing signals to converter 76b. Control interface 134 communicates with converters 76 and transmit adjuster 74b.

10 According to the illustrated embodiment, diversity system 22c includes features for transmitting signals such as converter 76b. Converter 76b comprises an up-converter that converts the frequency of outgoing signals from a baseband frequency band to an RF frequency band. According to the illustrated embodiment, converter 76b includes a local oscillator (LO) 140, a quad modulator 142, an  
15 automatic gain control (AGC) 144, amplifiers 146, and an interface 148 coupled as shown. Local oscillator 140 receives signals from a transmit voltage-controlled oscillator (VCO) and a transmit phase-locked loop (PLL) 149 and generates a clock signal. Quad modulator 142 modulates signals, AGC 144 controls the amplitude of signals, and amplifiers 146 amplify signals. Interface 148 communicates with  
20 baseband processor 78, converter 76a, and transmit adjuster 74b.

According to the embodiment, transmit adjuster 74b may adjust signals using one or more quality indicators that need not be provided by baseband processor 78. According to one embodiment, transmit adjuster 74b may receive quality indicators from an alternate source other than baseband processor 78. Transmit adjuster 74b may  
25 receive quality indicators from, for example, a memory interface 168, a general purpose interface, a serial interface, other suitable interface, or any combination of the preceding.

According to another embodiment, transmit adjuster 74b may generate quality indicators. According to the embodiment, transmit adjuster 74b may receive a signal  
30 comprising signal information and generate a quality indicator from the signal information. The signal information may describe, for example, transmit or receive AGC or transmit or receive power. As an example, transmit adjuster 74b may



generate a reverse power control bit from a transmit AGC signal or a receive AGC signal. Transmit adjuster 74b may sample an AGC signal for a power control group and an adjacent power control group and compare the samples. The comparison may indicate an increase or decrease from which the reverse power control bit may be  
5 determined.

According to one embodiment, transmit adjuster 74b may calculate at least some of the quality indicators, receive at least some of the quality indicators from baseband processor 78, receive at least some of the quality indicators from an alternative source to baseband processor 78, or any combination of the preceding

10 Transmit adjuster 74b may include an interface, a power control bit detection block, control logic, a digital processing block, a test bus, a memory bus, one or more vector modulators, one or more driver amplifiers, one or more power amplifiers, other suitable device, or any combination of the preceding. The power control bit detection block compares the transmit AGC signals of power control groups such as adjacent  
15 power control groups to generate reverse power control bits. The control logic controls the operation of the vector modulators, driver amplifiers, and power amplifiers. The control logic instructs the vector modulators, driver amplifiers, power amplifiers, or any combination of the preceding to implement the signal adjustments. As an example, one channel may support PCS CDMA and another channel may  
20 support cellular CDMA. Transmit adjuster 74b and baseband processor 78 may use dedicated or separate buses.

According to the illustrated embodiment, transmit adjuster 74b includes amplifiers 160 and 164 and SAWs 162 and 166. Amplifiers 160 and 164 amplify outgoing signals, and SAWs 162 and 164 filter the outgoing signals. According to one  
25 embodiment, amplifiers 160a and 164a amplify outgoing signals for one channel path, and amplifiers 160b and 164b amplify outgoing signals for another channel path. SAWs 162a and 164a filter the outgoing signals channel path for one channel path, and SAWs 162b and 164b filter the outgoing signals for another channel path. Transmit adjuster 74b may be fabricated using, for example, a SiGe BiCMOS  
30 process, and may be fabricated as a VQFN package.

RF filters 72b filter outgoing signals, and may include a diplexor 110 and one or more duplexors 112. Antenna elements 70 of antenna system 40 transmits the signals.

5 Various modifications, additions, or omissions may be made to system 22c without departing from the scope of the invention. Moreover, the operations of system 22c may be performed using logic comprising hardware, software, or any combination or arrangement of processors or modules suitable for adjusting a signal as disclosed.

10 Although an embodiment of the invention and its advantages are described in detail, a person skilled in the art could make various alterations, additions, and omissions without departing from the spirit and scope of the present invention as defined by the appended claims.